Atmospheric clear-sky longwave radiative cooling and precipitation

Richard Allan

Environmental Systems Science Centre, University of Reading

The University of Reading

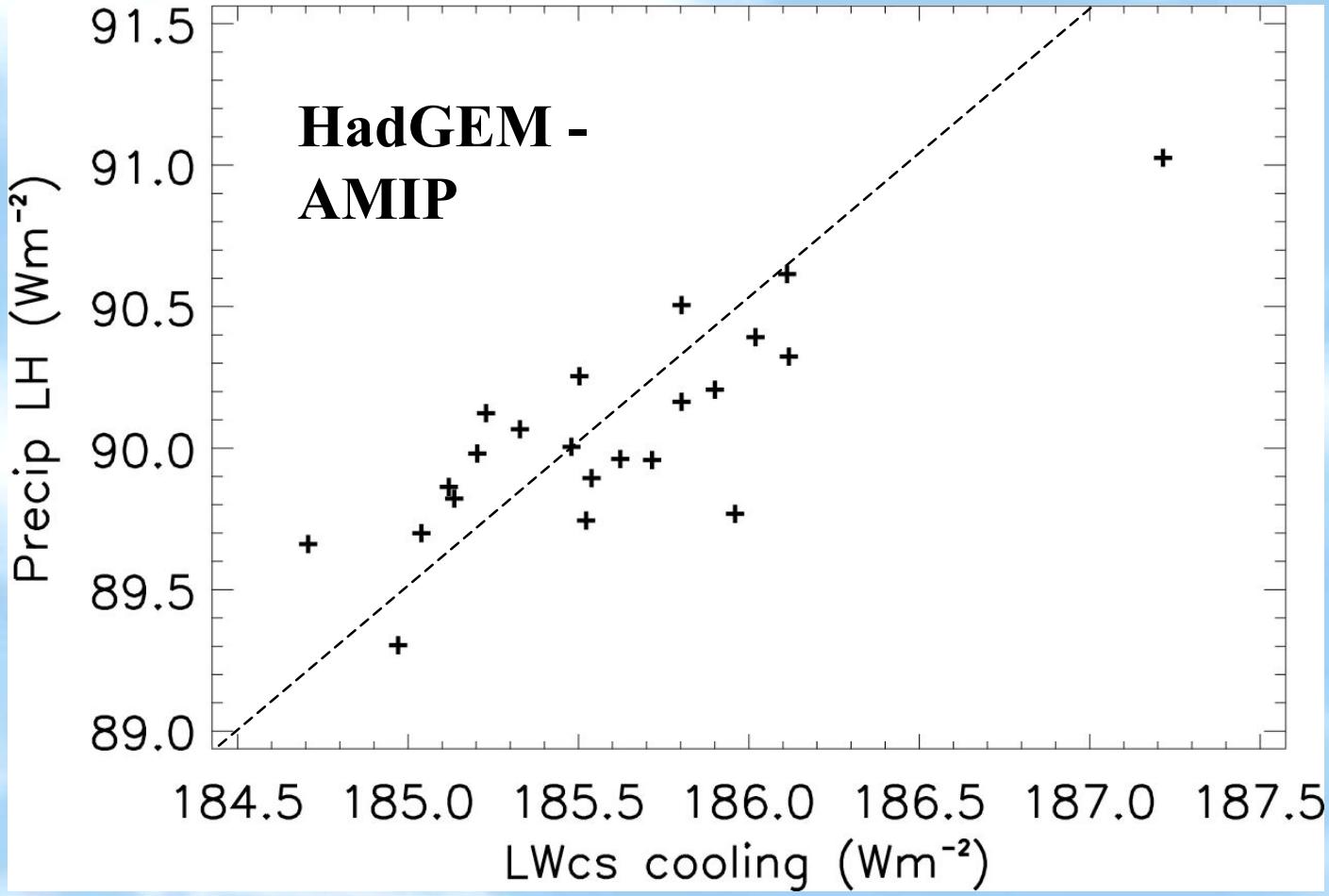
Introduction

- Clear-sky radiative cooling:
  - radiative convective balance
  - atmospheric circulation
- Earth's radiation budget
  - Understand clear-sky budget to understand cloud radiative effect
- Datasets:
  - Reanalyses – observing system
  - Satellites – calibration and sampling

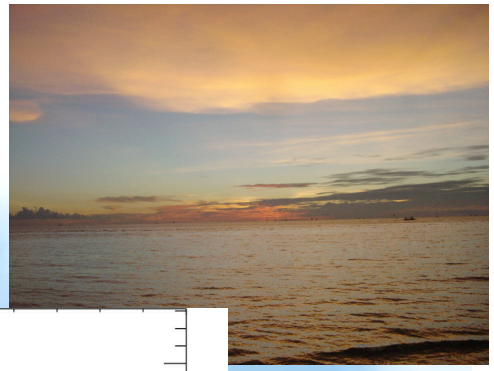
Datasets used

- Surface and Top of Atmosphere clear-sky LW flux
- Column integrated water vapour (CWV)
- Reanalyses:
  - ERA-40 (1979-2001); NCEP-1 (1979-2004)
- Satellite data
  - ERBS, ScaRaB, CERES (clear-sky OLR)
  - SMMR, SSM/I V5 (CIWV)
- Combination datasets:
  - SRB Rel. 2(1983-1994)…reanalysis?
  - SSM/I, da Silva, ERA40, Prata (1996) → surface net LWc
- IPCC AR4 models

Links to precipitation



Tropical Oceans

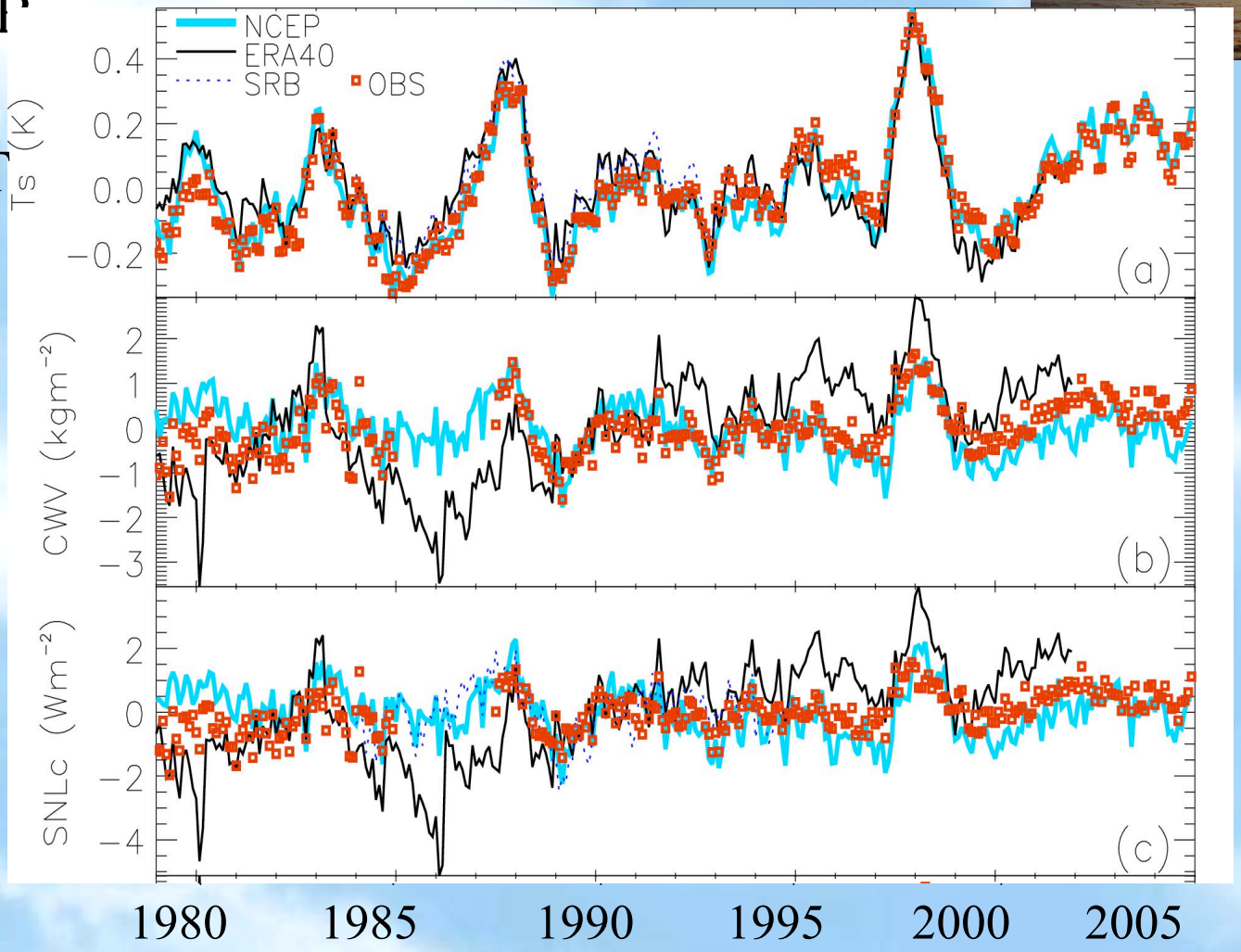


ERA40

NCEP

SRB

- HadISST
- SMMR, SSM/I
- SSM/I, Prata



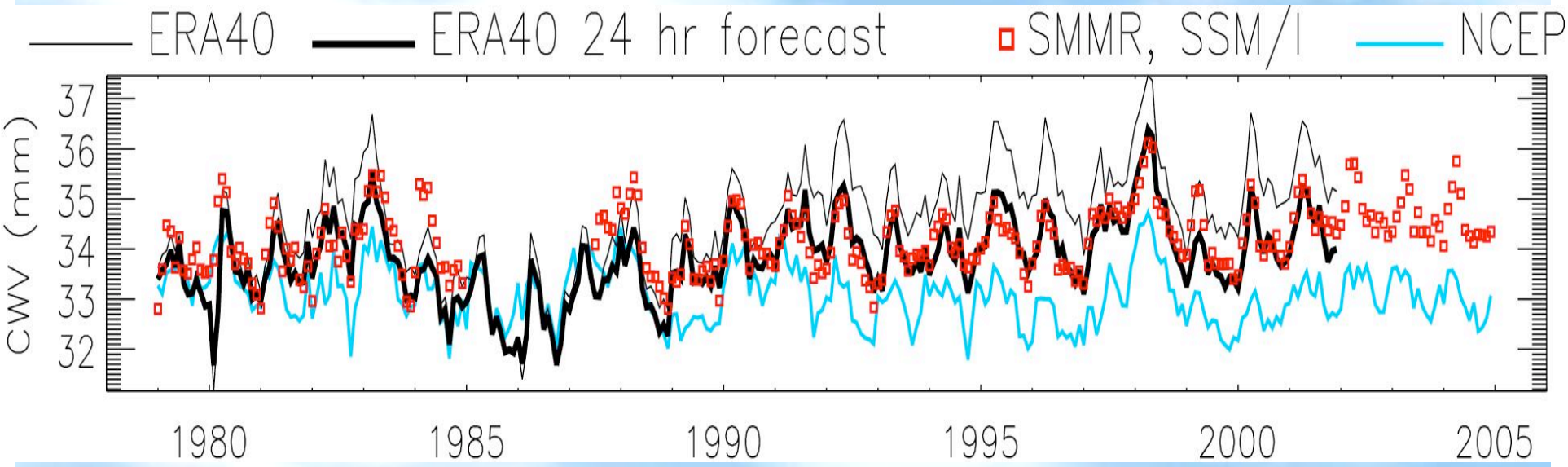
Ts

CWV

LWc

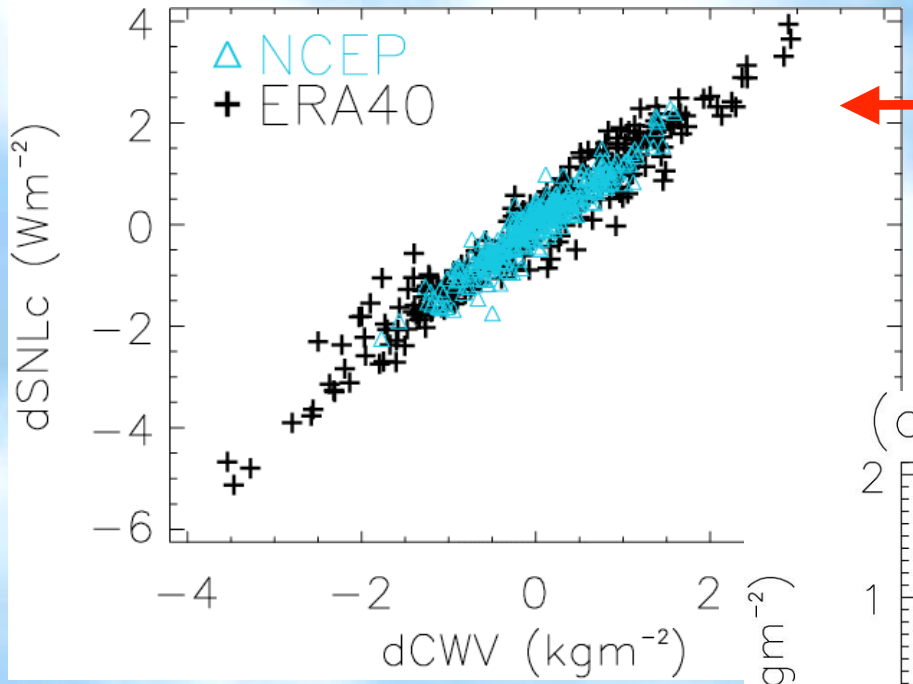
SFC

Spurious variability in ERA40



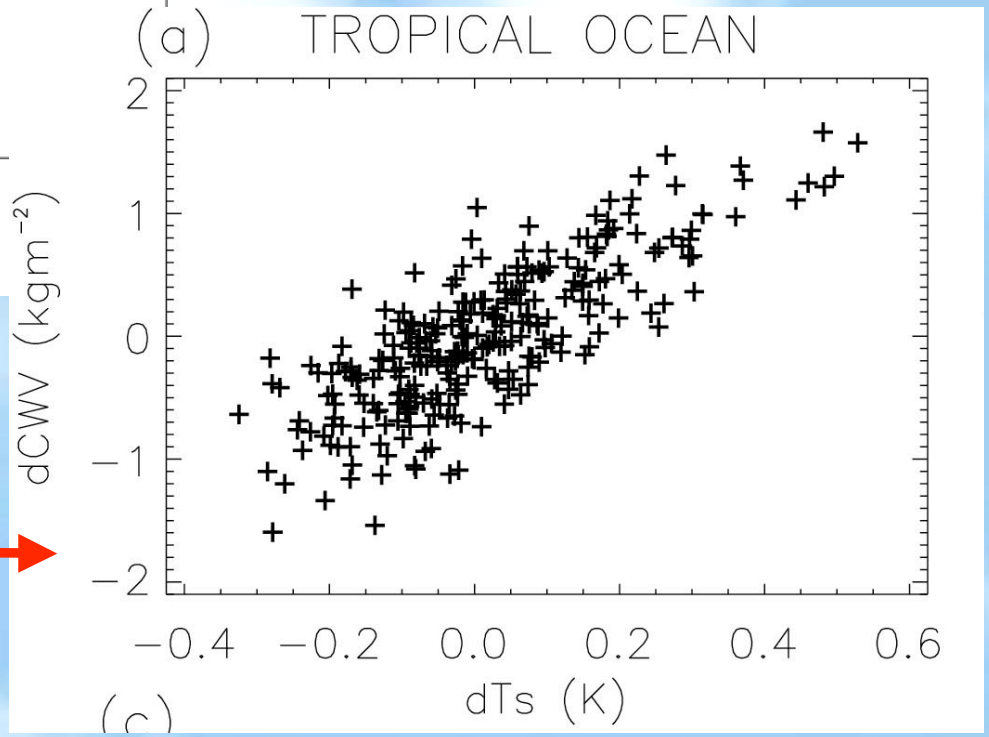
- Improved performance in water vapour and clear-sky radiation using 24 hour forecasts

Surface LWc and water vapour

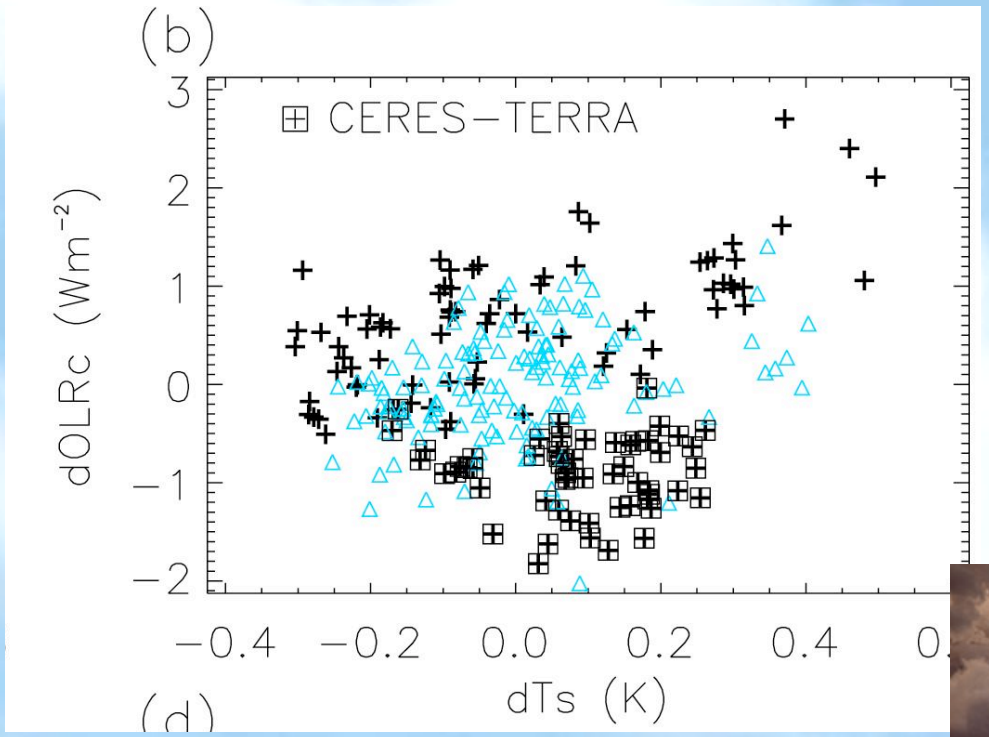


dLWc/dCWV ~ 1.5 Wkg^{-1}

dCWV/dTs ~ 3 $kgm^{-2}K^{-1}$

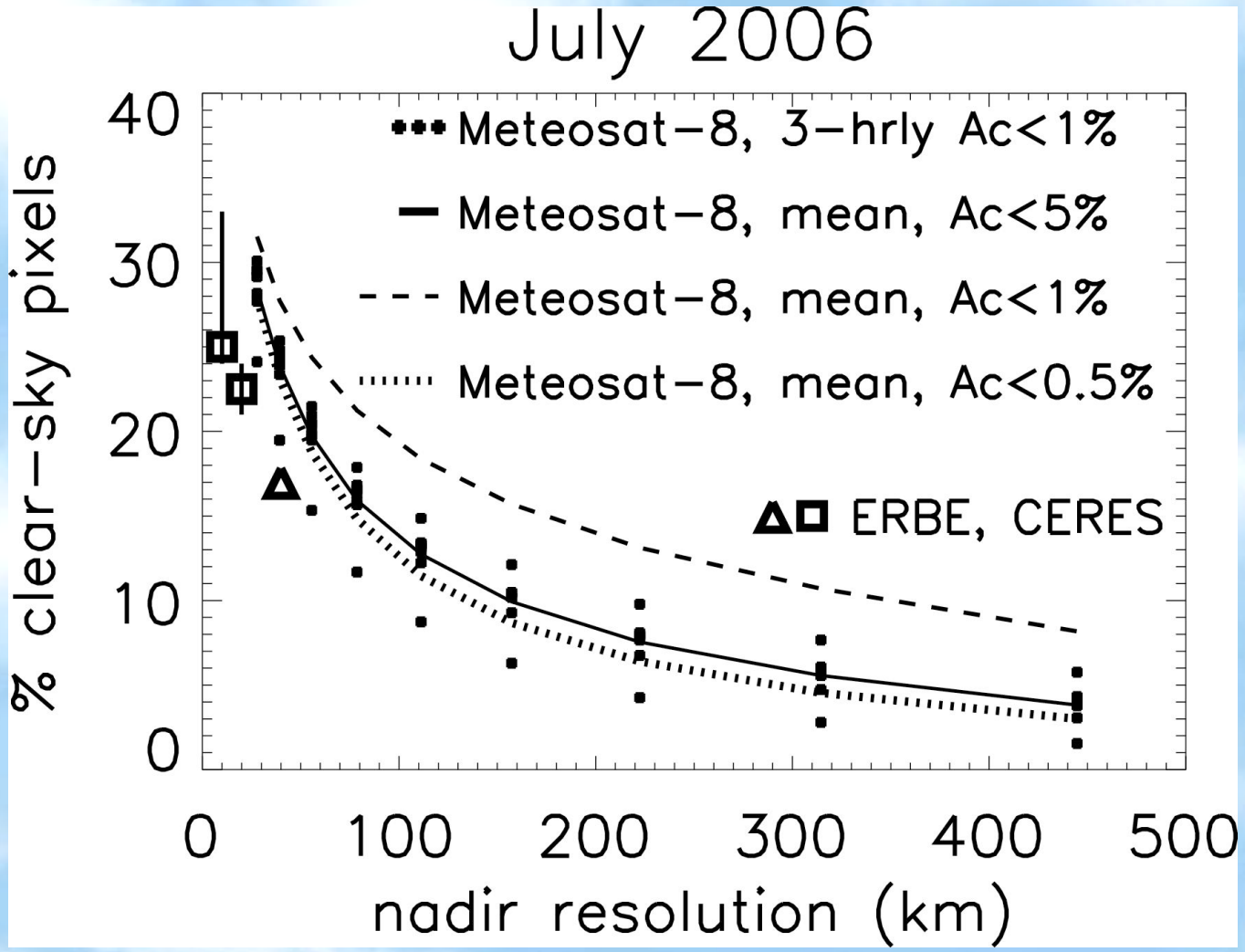


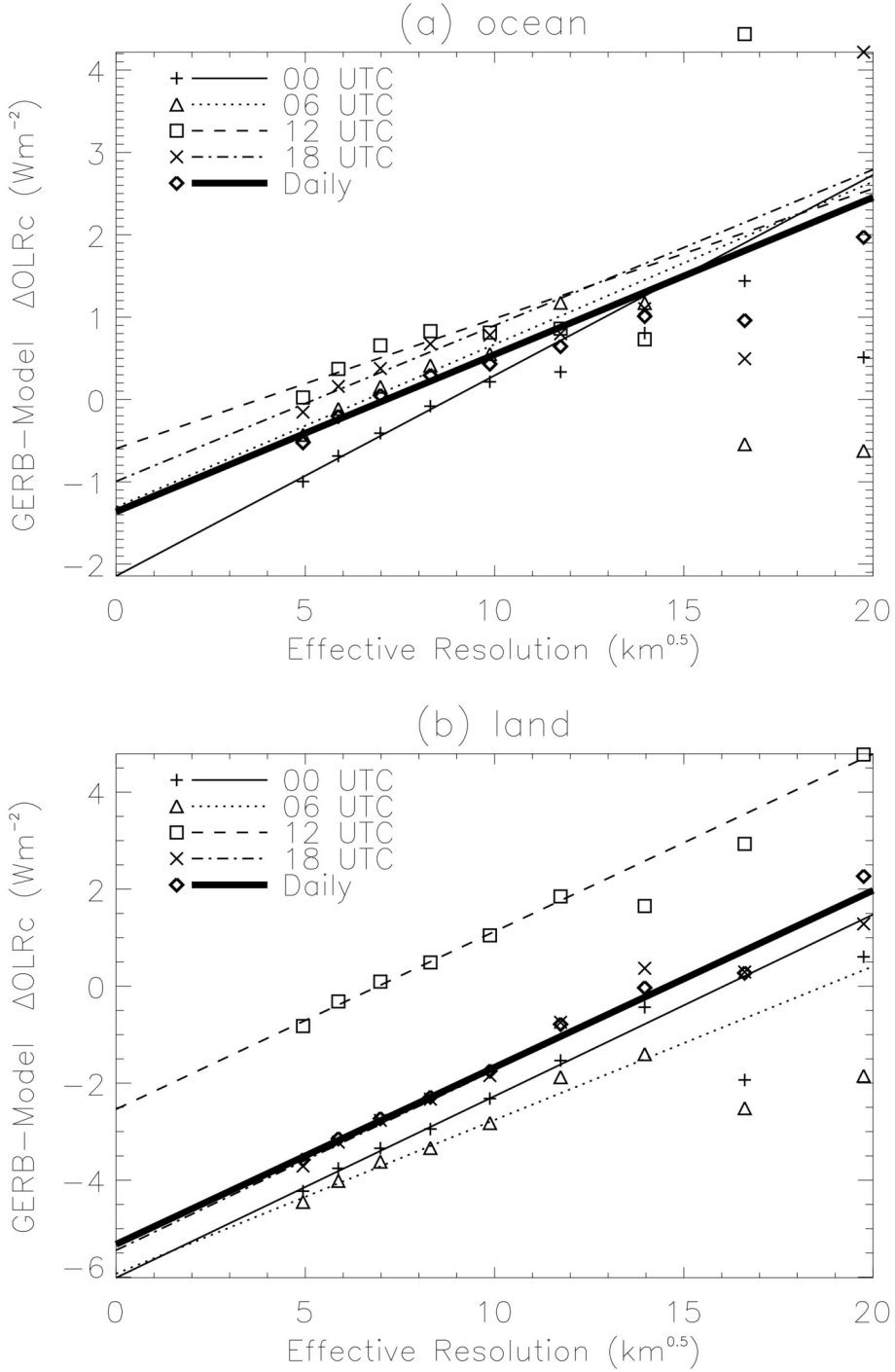
Clear-sky OLR with surface temperature: + ERBS, ScaRaB, CERES; SRB



Calibration or sampling?

Clear-sky vs resolution





Sensitivity study

- Based on GERB-SEVIRI and model simulations of OLR and cloud products over ocean:
- dOLRc/dRes ~0.2 $Wm^{-2}km^{-0.5}$
- Suggest CERES should be biased low by ~0.5 Wm^{-2} relative to ERBS

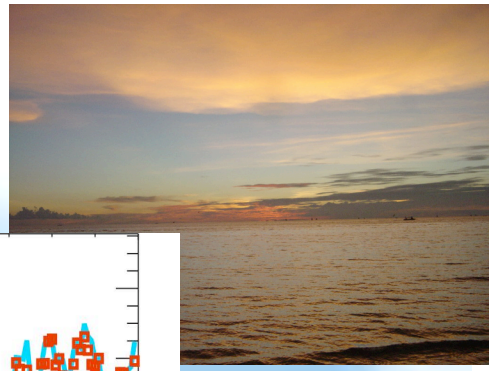
Tropical Oceans

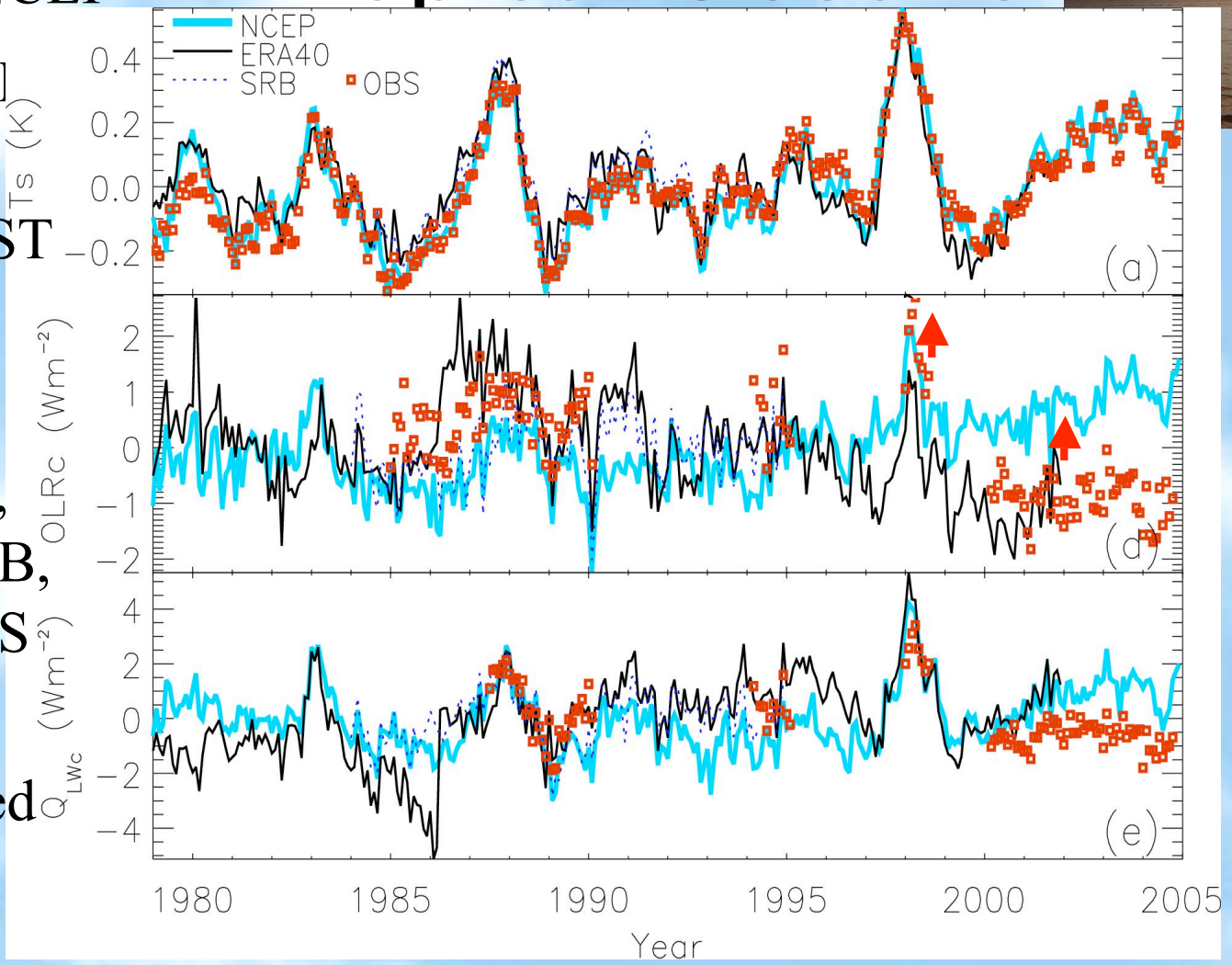
ERA40

NCEP

S]

- HadISST
- ERBS, ScaRaB, CERES
- Derived



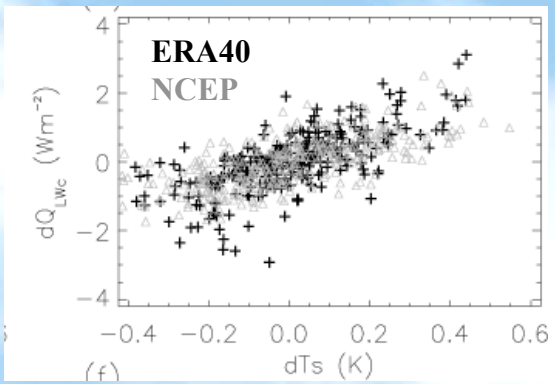


Surface Net LWc

Clear-sky OLR

Clear-sky Atmos LW cooling

Q_{LWc}

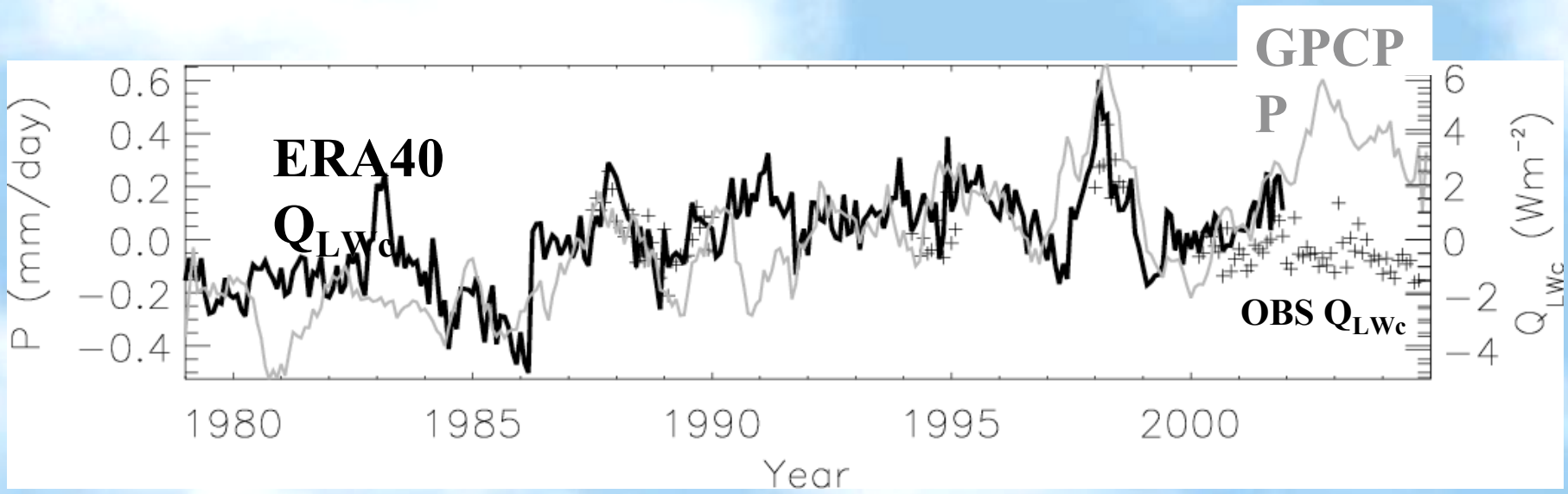


Linear least squares fit

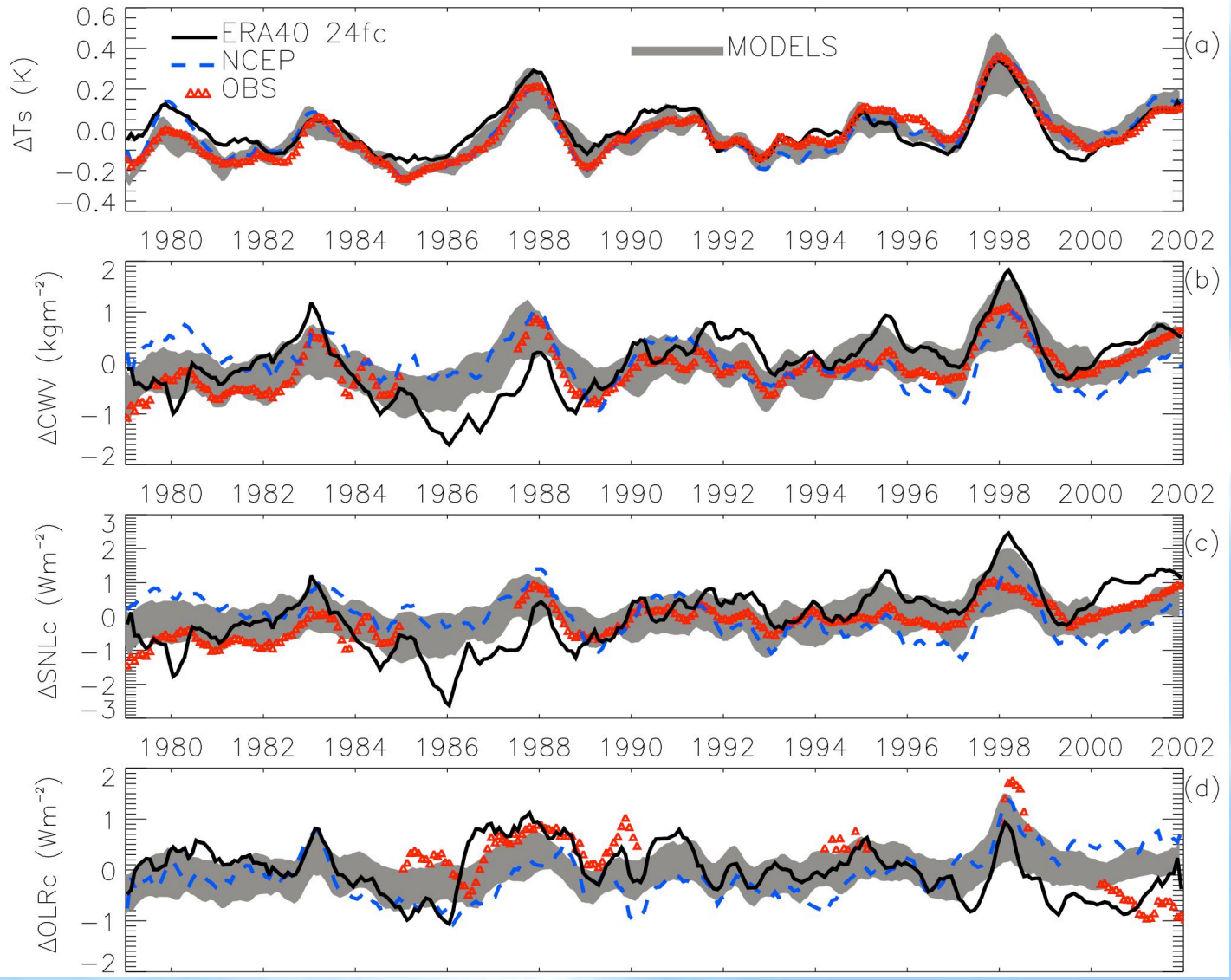
- Tropical ocean: descending regime

Dataset	dQ_{LWc}/dTs	Slope
ERA-40	3.7±0.5	$Wm^{-2}K^{-1}$
NCEP	4.2±0.3	$Wm^{-2}K^{-1}$
SRB	3.6±0.5	$Wm^{-2}K^{-1}$
OBS	4.6±0.5	$Wm^{-2}K^{-1}$

Implications for tropical precipitation (GPCP)?

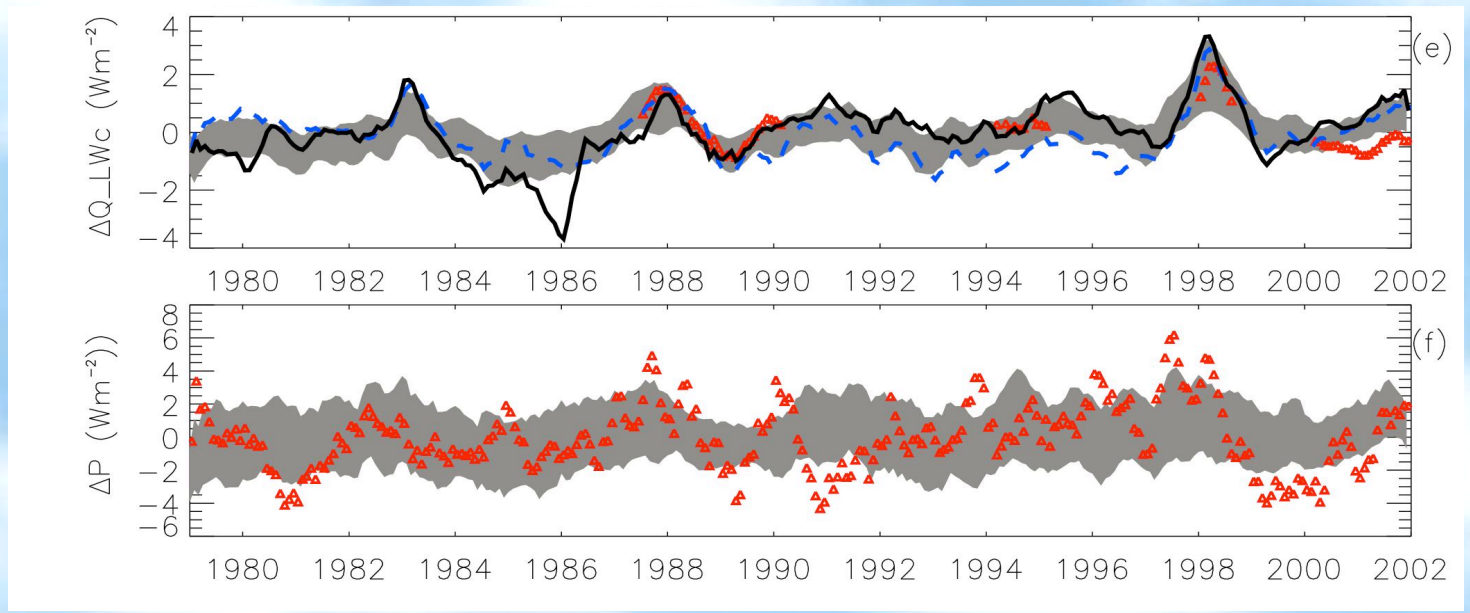


IPCC AR4 models: tropical oceans



- SST
- CWV
- Net LWc
- OLRc

IPCC AR4 models: tropical oceans



- Q_{LWc}
- Precip

Conclusions

- Intercomparisons of datasets: clear-sky LW at SFC, TOA, ATM
- Reanalyses: observing system changes
- Satellites: calibration, sampling

- Increase in clear-sky LW cooling of atmosphere of ~3-5 $Wm^{-2}K^{-1}$
- All-sky changes? Models?